

SCIENTIFIC POSTERS

1. Characterising breast tumours with quantitative perfusion MRI: first results

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Purpose: Previously we demonstrated the feasibility of quantifying perfusion parameters in human breast tumours using a deconvolution analysis of dynamic contrast-enhanced (DCE) MRI. Now we investigate the added value of these parameters in tumour characterisation.

Materials and methods: The routine MR mammography protocol was first applied, which included whole breast DCE MRI (0.1 mmol/kg Gd-DTPA 10 s/dynamic) sequence. The slice in which the lesion enhanced maximally was located in the subtracted DCE MR images. A second bolus of 0.1 mmol/kg Gd-DTPA was injected and a dynamic single slice Turboflash acquisition (600 dynamics with a temporal resolution of 0.3 s) was performed at that slice position. The signals were first converted to tracer concentrations, which was then deconvolved pixel-by-pixel, with an arterial input function in the aorta. Finally, the parametric maps of tumour blood flow (TBF), tumour extracellular volume (TEV) and mean transit time (MTT) were generated. Perfusion values were compared with literature values.

Results: In the initial data of four malignant and two benign tumours, the parametric maps clearly differentiated tumours from the surrounding breast tissue. Mean TBF in the malignant tumours (38.4 ml/100 g per min) was consistent with the literature values. TBF and TEV values were higher and MTT values were lower in the malignant tumours compared to the benign ones.

Conclusion: Preliminary results suggest that a pixel-by-pixel deconvolution analysis of the DCE MRI data of breast tumours provides regional perfusion parameters, which can be a valuable tool in the tumour characterisation.

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2. Towards quantitative radiology in oncology: critical assessment of diameter and volume-based concepts for measuring growth

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Cancer therapy response classifications like RECIST or WHO criteria are based on growth estimates. It is well known that growth is indirectly measured as a difference of primary measurements. Problems related to error amplification inherent in such indirect measurements are less well known. We present statistical studies explaining the high probability of misclassifying growing or shrinking lesions due to observer variability of lesion diameter measurements as stable disease using error amplification theory for the input-output system: (size1, size2) → growth estimate. For example, a relative variability in RECIST diameter measurements yields increased (about 22 times) relative variability of growth estimates for lesions changing by 20% v_{01} . For faster growing lesion the amplification factor decreases but is still seven at 100% growth. Thus very high reproducibility of primary measurements is required to obtain acceptable reproducibility for derived growth estimates. By performing volumetric measurements the variability amplification from initial measurement to computed growth is reduced by a factor of three. Software-assisted 3D measurements are less susceptible to observer induced variations and enable the computation of growth estimates with reproducibility at least 4–5 times better than measurements based on manually drawn diameters. Accuracy of growth estimates will be of crucial importance in CT based studies of novel, less toxic pharmaceuticals aiming to reduce tumour growth rather than tumour size. This motivates continued research on tools for volumetric assessment of metastases and tumours in order to improve treatment planning and monitoring with respect to convenience, accuracy, robustness and speed and to make quantitative radiology aiming to assess tumour growth become a reliable and affordable clinical routine.

3. Combined treatment of large hepatocellular carcinoma (HCC) with simultaneous ethanol injection (PEI) and radiofrequency ablation (RFA)

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Purpose: To show the possibilities of PEI-RFA in combination in percutaneous treatment of large-sized HCC (>4 cm).

Materials and methods: From April 1998 to February 2004 we treated 40 patients with Child A or B chronic liver disease and with single, big HCC: diameter 41–70 mm (mean, 47 mm), volume 41–190 cm³ (mean, 88 cm³). Under general anaesthesia, the patient first underwent US-guided ethanol injection in the peripheral areas of the tumour (10–20 ml through a 20-G Chiba needle, mean 13 ml). Two to four minutes later RFA was performed, using a 14G, 12-hook needle and 250 W monopolar unit.

Results: Post-treatment CT follow-up showed complete necrosis in 28/40 cases (70%). Eleven HCCs showed 70%–95% necrosis after the first session and complete necrosis after the second session. In one patient three treatment sessions were needed to obtain complete necrosis. In one patient infection developed, requiring first percutaneous drainage and then surgical curettage. No other major complication occurred and no patient showed relevant change in liver function. Seven subjects died 7–45 months after treatment. No local recurrence developed in the remaining 33 cases (8–79 months follow-up).

Conclusion: Effective percutaneous treatment of large-sized HCC (>4 cm) is difficult, mainly because of limitations in obtaining an adequate security margin. PEI and RFA combination determines a more than simply additive narcotising effect, allowing complete control of large size HCC, even in areas difficult to treat (nodules adjacent to vascular or biliary structures, located peripherally, or located subphrenically).

4. Size of liver metastases at different CT phases compared to macroscopic size in histological specimens

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Aim: To investigate whether the size of hepatic metastases at different CT phases is significantly different from macroscopic measurements of the actual specimen and to investigate in which CT phase the metastasis appears closest to the size of the metastasis in the specimen. To investigate if the measurement of metastasis size at different CT phases would influence oncologic judgement about progression or regression of disease.

Methods: Ten patients with a total of 16 hepatic metastases from mostly colorectal carcinoma underwent spiral computed tomography (CT) and surgery within 5 days. CT of the liver was performed with 4 mm collimation before and after intravenous contrast agent administration in the arterial, in the portal-dominant, and in the 5 min delayed phase. After surgery the liver specimen was dissected by the pathologist into 3 mm axial slices in exactly the same orientation as the CT images. The specimen slices were digitally photographed and the maximum diameter was measured on magnified images.

Results: The mean metastasis size was 2.6 cm as measured on the specimens. On average, liver metastasis appeared 32% smaller on non contrast enhanced CT, 27% smaller in the arterial phase without the hypervascular border, 18% smaller in the arterial phase with the hypervascular border, 13% smaller in the portal-dominant phase, and 20% smaller in the delayed phase each compared with the actual specimen size.

Conclusion: Metastatic lesions of the liver mostly appear smaller on CT than in the specimen. Closest to the actual specimen size are lesions measured in the portal-dominant phase. Due to the variability in different CT phases progression or regression of metastatic disease should only be judged by comparing metastatic lesions in the same phase.

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5. Contrast-specific ultrasound (Cs-US): a promising diagnostic technique in abdominal oncology

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Purpose: CS-US selectively detects the harmonic signals produced by microbubble contrast agents within large and small vessels while tissue signal is minimised showing the microvasculature within tumours due to neoangiogenesis. We report our experience with CS-US in abdominal neoplastic imaging.

Materials and methods: We performed 281 CS-US studies on 254 patients with primitive or metastatic abdominal disease (liver, pancreas, spleen, kidney, adrenal and/or lymph nodes). Following baseline ultrasound the contrast agent SonoVue (Bracco, Italy) was injected. Imaging with CS-US software (CnTI, Esaote, Italy) was started immediately and lasted 3–5 min. Retrospectively we compared CS-US with conventional ultrasound first, and with CT, MRI, and PET, regarding sensitivity, specificity, lesion conspicuity (lesion-to-parenchyma contrast) and lesion size assessment.

Results: No patient had any adverse reaction. CS-US allowed detection of a greater number of lesions in comparison with conventional ultrasound. Moreover, the lesions identified had a greater conspicuity and correlated better in size with the other techniques if compared to ultrasound. The additional value of CS-US was considered absent (11% of cases), low (19%), medium (25%), and high (45%). In 19% of cases the therapeutic program was modified.

Conclusion: Contrast-enhanced ultrasound is a simple, minimally invasive and accurate tool in the evaluation of abdominal cancer patients. It increases the contrast resolution of conventional ultrasound, diminishing the need for more expensive and radiobiologically invasive tools. CS-US can be employed as a problem-solver in the assessment of specific doubts or discrepancies of other imaging techniques. However, a larger and more homogeneous series is necessary to validate this new, promising technique and to define its inclusion in cancer patient diagnostic algorithms.

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6. Use of oral contrast agents in upper gastrointestinal staging CT scans of oesophageal carcinoma

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Background: The importance of special interest radiology in the stage directed management of oesophageal carcinoma has been previously described. The use of negative oral contrast media (water or Calogen[®]) has been recommended prior to computed tomography (CT) of the upper abdomen.

Aim: To compare the three negative contrast media: water (500 ml), Calogen[®] (500 ml) and equal quantities of water and Calogen[®] in assessment of oesophago-gastric tumours.

Methods: Sixty-four patients referred for upper GI staging scans were prospectively randomised to each group. Anatomical distension of the oesophagus, stomach, and duodenum and wall thickness of the lesser and greater curvatures were measured.

Results: There is significant improvement in distension and assessment of the stomach wall ($P < 0.0001$) with a mixture of water and Calogen[®] or Calogen[®] alone compared to water alone. Calogen[®] alone is significantly better for achieving duodenal distension ($P = 0.0055$). There was no significant difference ($P = 0.730$) in oesophageal distension in either group.

Conclusion: A mixture of equal quantities of Calogen[®] and water is recommended for upper GI tumour staging CT, and Calogen[®] alone where duodenal distension is required.

7. Pitfalls in MR imaging of rectal carcinoma

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Accurate preoperative staging of rectal cancer is vital for treatment planning if optimum local control of primary disease is to be achieved. Staging accuracies of between 65% and 100% have been reported with MRI. Radiologists should be aware of potential imaging pitfalls which can reduce staging accuracy. Standard MR imaging protocols include: T2W-FSE sagittal and axial sequences through the pelvis with a pelvic phase array coil, smaller field of view thin section T2W-FSE oblique axial images at right angles to the tumour and T1W axial sequences. Pitfalls associated with scan technique include incorrect coil positioning leading to signal loss, and incorrect planning of oblique axial sequences. Failure to plan exactly perpendicular to the tumour long axis results in increased partial volume effect. This is more pronounced as tumour extends around the curvature of the rectum and more than one block may be necessary for coverage. Errors in staging most commonly occur in differentiating T2 and early T3 stage lesions. Overstaging can occur when tumour-induced fibrosis extends into the perirectal fat. Tumour necrosis and the presence of mucin lakes can be misdiagnosed as bowel wall perforation (T3). Preoperative radiotherapy can make tumour delineation difficult by inducing further fibrosis and submucosal oedema. Identification of the mesorectal fascia is important for predicting the narrowest potential circumferential resection margin. This can be difficult post radiotherapy and also in low rectal tumours where space between rectum and adjacent levator plate is naturally limited. We will illustrate these pitfalls and provide histological confirmation of staging where available.

8. Gastro-intestinal and abdominal metastasis in patients with melanoma: X-ray, US, CT and MRI findings

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Aim: X-ray, US, CT, and MRI findings related to the various gastro-intestinal and other intra-abdominal locations of melanoma metastasis are described. We particularly highlight the typical and atypical features recognisable in patients with melanoma metastasis by using a variety of diagnostic techniques.

Background: Metastatic melanoma is a complex occurrence because of the unpredictable spreading modality, variability of anatomical location, and variability of imaging features.

Imaging findings: This exhibit is intended as a guide to the abdominal imaging possibilities and limitations in melanoma metastases imaging. Locations illustrated include liver, spleen, stomach, bowel, kidney, peritoneum, retroperitoneal/perirenal space, and ovary. Skeletal and cutaneous lesions should also be recognised while exploring the abdomen. Complications may include haemorrhage, intestinal obstruction, and intestinal intussusception.

Conclusion: Melanoma metastasis may have a wide spectrum of anatomical locations within the abdomen and a variety of related imaging patterns. Radiologist should be aware of several imaging pitfalls and clues to diagnosis.

9. Multi-modality preoperative imaging of pancreatic insulinomas

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Insulinomas are rare islet cell functional neuroendocrine tumours of the pancreas. They pose a diagnostic challenge to physicians, surgeons and radiologists alike. Typically the diagnosis is often suggested clinically due to their release of insulin causing hypoglycaemic effects. Biochemical testing confirms them with the evidence of fasting hyperinsulinaemia. Imaging aims to detect, localise and stage the tumour prior to surgery which may be radiologically difficult due to their small size at clinical presentation. In the past, small or subtle lesions were difficult to identify but modern imaging techniques have improved their detection. Conventional ultrasound only detects 7%–60% but it is cheap, safe, non-invasive, and is a practical first line investigation. High resolution ultrasound, endoscopic ultrasound and contrast enhanced Doppler techniques assist in detecting small lesions. Initially, the sensitivity of CT was 21% and that of MRI was 7%. However, with experience and technological advances, reported sensitivities are greater than 80% for both modalities. In difficult cases, selective arterial angiography and venography or functional imaging with radio-isotopes such as Octreotide may be helpful. This poster demonstrates the radiological features and imaging techniques utilised in the detection of these tumours.

Learning objectives: (1) To review the radiological manifestations of insulinomas; (2) to discuss the impact of ultra-fast multiphase imaging techniques in identifying small lesions; (3) to demonstrate the interactive role between functional imaging and conventional imaging and imaging strategies which should be employed in their detection.

10. Contrast-specific sonography imaging of focal liver lesions: significance of portal-phase dependent lesional hypoechoic appearance

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Aim: A hypoechoic image during portal-sinusoidal phase of harmonic contrast-specific ultrasound (US) of the liver is commonly considered diagnostic for liver metastasis. Our purpose was to assess the prevalence and significance of these hypoechoic liver lesions on a large series of cancer patients.

Methods: We retrospectively evaluated contrast-specific US hepatic studies of 221 patients studied for different questions mainly dealing with extrahepatic cancer. All patients had previously undergone conventional US imaging. A low-mechanical index US technology was employed (CnTI, Esaote, Italy). A second-generation, contrast agent was administered (SonoVue, Bracco, Italy). Imaging started immediately after injection and lasted 6 min.

Results: Hypoechoic liver lesions were identified in 60 patients (31 women and 29 men, aged 22–81 years). Eleven subjects with >10 lesions detected and four subjects without a confirmed final diagnosis were excluded from statistical analysis. Forty-five patients with 116 hypoechoic lesions had a final diagnosis (CT and/or MRI-correlation in 30 cases, US follow-up in eight, and needle-aspiration in seven). Patients showed 1–10 focal lesions. Definitive diagnosis was: metastasis (95 lesions/30 patients); abscess (13 lesions/8 patients); lymphoma (3 lesions/2 patients); intrahepatic cholangiocellular carcinoma (2 lesions/2 patients); thrombosed haemangioma (1 lesion/1 patient); dysplastic nodule in cirrhosis (1 lesion/patient), and direct infiltration from gall-bladder carcinoma (1 lesion/1 patient).

Conclusions: In contrast-specific US imaging a hypoechoic liver lesion at venous-phase can be considered diagnostic for a malignancy and particularly for liver metastasis. Almost any benign lesion appears as hypoechoic during portal-sinusoidal phase of liver opacification (with the exception of thrombosed haemangiomas and such hepatic abscesses, that shows several other typical features).

11. Heat shock protein expression by percutaneous radiofrequency ablation of hepatocellular carcinoma *in vivo*

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Aim: Tumour cells respond to stress such as heat with the synthesis of heat shock proteins (HSPs). HSPs are crucially important in anti-tumoral host reactions. The purpose of our study was to evaluate the expression of HSPs before and after treatment with percutaneous radiofrequency (RF) ablation in hepatocellular carcinoma (HCC).

Materials and methods: Twenty-one human HCCs were inoculated in athymic rats. RF ablation was performed applying 100–500 W of energy, and tumours were excised 6–24 h later. Furthermore, in one patient with unresectable HCC, CT-guided biopsies were obtained from the tumour before and 24 h after RF ablation (ablation time, 10 min; total RF energy, 19 000 W). Immunohistochemistry of the specimens determined the expression of HSP 70 and 90.

Results: In the animal model, HSP 70 expression was 0% and HSP 90 expression was 30% before RF ablation. After treatment, the HSP expression was significantly increased, with a maximum after 12 h (HSP 70, 60%; HSP 90, 90%). The expression of HSPs correlated with the energy applied. The specimens of the one patient treated showed an eight-fold increase in HSP 70 expression and a 1.2-fold increase in HSP 90 expression. No adverse side effects were observed.

Conclusion: In both an animal model and in the treatment of one patient we demonstrated an increase of HSP expression subsequent to RF ablation in HCC. Our results may be of relevance in further therapeutic anti-tumour strategies.

12. MRI appearances of recurrent cervical carcinoma

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Objective: Our aim was to describe the patterns of disease recurrence and residual disease in patients treated for cervical carcinoma and to evaluate imaging features of recurrence and or residual disease from post treatment change.

Materials and methods: In a retrospective observational study MR scans of 48 patients with recurrent or residual cervical carcinoma were reviewed by two radiologists. Sixteen patients had undergone primary surgical treatment. Recurrence was confirmed by histology (28), clinical and radiological progression (6) and by patient death (14) due to progressive disease. MR images were analysed for the site of recurrent/residual disease, signal characteristics and invasion of adjacent structures.

Results: There were 29 recurrences, while 19 patients had residual disease. Most of the recurrences (70.4%) occurred within a year of the start of treatment. Twelve (25%) occurred within 6 months.

Recurrent disease was confined to the cervix in 6 (66.7%) and vaginal cuff in 3 (33.3%) patients. The recurrent tumour was iso-intense to the adjacent muscles on T1W sequence in 95.3% and hyperintense on T2W in 88.9%. The cervix was involved in every case of residual disease and in 10/29 (34.5%) patients with recurrent disease. The vaginal cuff was the epicentre of recurrent disease in 14 (87.5%) post surgical patients. Parametrial invasion was present in 13 (81.3%) patients treated surgically and in 22 (68.8%) of those receiving chemoradiotherapy. Involvement of the utero-sacral ligaments was seen in 8 (57.1%) surgical patients and 14 (43.8%) non-surgical ones. Bladder invasion was seen in 4 (25.0%) patients treated surgically and 3 (9.4%) of those treated with chemoradiotherapy. Radiotherapy change within the marrow was seen in 13 (27.0%) patients in total, while bone metastases were present in 4 (8.3%) patients.

Conclusion: Recurrent cervical carcinoma can present with varied imaging features. Knowledge of the patterns of recurrence can aid early detection and may determine further therapeutic options.

13. Pitfalls in MRI staging of cervical cancer

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Aim: To appreciate potential errors and pitfalls in interpreting MRI during staging of cervical cancer, and to learn strategies and techniques to avoid these potential errors.

Method: MRI of 132 women undergoing staging between 1994 and 2004 was retrospectively reviewed for potential pitfalls and errors. Eighty-one patients underwent surgery enabling direct surgical correlation.

Results: In 11/81 patients, tumour was not detected on MRI (false negatives). In 8/11 patients, histological tumour was <1 cm in size. In 2/11, residual tumour infiltrated the entire cervix without causing mass effect or differential MR signal intensity. In 1/11 co-existing cervical endometriosis obscured the tumour. In 8 (10%) patients, MR tumour size was overestimated by 2–3 mm due to surrounding inflammatory changes. In 4 (5%), there was false positive parametrial invasion. All four tumours were large exophytic tumours. The overall sensitivity of MR in detection of nodal metastasis was 63%, specificity 56% and accuracy 89%. Metastatic nodes with cystic change are a potential pitfall resembling physiological ovarian tissue. Vaginal wall appearances are a further pitfall. Folding and post biopsy thickening can lead to false impression of tumour invasion thereby upstaging cervical carcinoma.

Conclusions: We present a range of pitfalls of staging MR imaging in detection, size estimation and parametrial extension. These include technical inadequacy, anatomical variants, confusion caused by co-existent disease and effects of previous intervention. We describe ensuing alterations in MR techniques and protocols which help avoid these pitfalls.

14. MR imaging appearances of malignant mixed Müllerian tumours of uterus and ovaries

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Purpose: To describe the MR imaging appearances of the rare malignant mixed Müllerian tumours (MMMT) of the uterus and ovaries.

Materials and methods: A retrospective observational study of 44 cases of MMMT with histological confirmation was performed. Imaging was reviewed by two radiologists for primary site, size, signal characteristics and invasion of local structures and spread.

Results: MR imaging was available in 18 cases (13 uterine and 5 ovarian) comprising 15 primary and 3 recurrent MMMTs. The mean tumour diameter was 8.2 cm (uterine 7.6 cm, ovarian 9.6 cm and recurrent 6.5 cm). All were isointense to muscle on T1W and hyperintense on T2W scans. The tumour was homogenous on T1W images in all but three cases, which had haemorrhagic high signal foci. Tumour heterogeneity was present in 14 (77.8%) cases on T2W scans with cystic change representing necrosis on histology. Of the uterine tumours, the commonest pattern was an endometrial tumour radiologically indistinguishable from endometrial carcinoma (8 patients). Myometrial invasion was seen in 5/8 patients (62.5%). The remaining five tumours had a large heterogeneous mass completely replacing the uterus. Ovarian MMMT presented with large masses (multiple in two of the three cases), peritoneal implants and ascites. All showed mixed cystic and solid components with haemorrhage in one and para-aortic, iliac and obturator lymphadenopathy in all three. All three cases of recurrent MMMT presented with a mass in the vaginal vault. Both ovarian recurrences had peritoneal deposits. No nodal enlargement was seen in these patients.

Conclusions: MMMT are rare tumours usually presenting as large pelvic masses which may involve either uterus or ovary. In the uterus MR imaging features may overlap with those of endometrial carcinoma or be more distinctive with complete replacement of the uterus by a heterogeneous, haemorrhagic necrotic mass. Ovarian MMMT presents with large a mass containing solid components with ascites and peritoneal deposits accompanied by enlargement of the pelvic nodes. Recurrent disease in both uterine and ovarian MMMTs has identical features presenting with large mass lesions with no lymphadenopathy.

15. Renal metastatic disease: a pictorial review of CT findings

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Aim: Haematogenous metastatic disease to kidney is an uncommon but complex occurrence. A wide spectrum of helical CT changes can be encountered in clinical practice with various pitfalls and need for differential diagnosis.

Methods: Cases are presented of renal metastasis from various sources: lymphoma, melanoma, pulmonary carcinoma, mammary carcinoma, pancreatic carcinoma, and contralateral renal tumour (synchronous or metachronous).

Results: Renal involvement may be unilateral or bilateral, isolated or in connection with a generalised tumour. The lesion may be limited to the renal parenchyma, bulge externally, or be primarily located in the perirenal space. Attenuation and contrast enhancement may vary. Renal normal structure is progressively infiltrated and destroyed.

Conclusions: There is a wide spectrum of findings recognisable in renal metastatic disease on helical CT images.

16. Image fusion between PET and CT for radiotherapy treatment planning for head and neck cancer

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Aim: To assess the potential benefits of [¹⁸F]FDG-PET for delineation of gross tumour volume in patients with head and neck cancer, as compared to CT.

Methods: From April 2004 to January 2005, 18 patients (15 male and 3 female) with mean age 62.8 years (range 46–82) were enrolled in this study. There were 15 patients with squamous cell carcinoma, one adenocarcinoma and one non-Hodgkin's lymphoma. Four patients were stage I, five were stage II, five were stage III, and three were stage IV. One patient had multiple myeloma. The localisation of the tumour was: nine oropharynx, three nasopharynx, four larynx, one parotid gland and one hypopharynx. For acquisition for all images, the patients were immobilised with a customised thermoplastic mask that was fixed to a flat table top. Co-registered PET/CT showed good fusion accuracy using an automatic method. Planning was performed in two steps: GTV delineation on CT and delineation of GTV based on [¹⁸F]FDG uptake on CT/PET.

Results: In six patients the GTV volume determined by CT/PET was smaller than the GTV volume determined by CT, in one patient the GTV volume CT/PET was larger than the GTV CT and finally in three patients PET was negative (two patients were PET-negative after induction chemotherapy, one patient surgically treated was PET-negative).

Conclusions: Our preliminary study confirms that the use of CT/PET for treatment planning for 3-D conformal radiation therapy improves the volume delineation compared with CT.

17. Digitally reconstructed radiographs as reference images in head and neck radiotherapy treatment verification

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Background: The accuracy of setup for head and neck cancer patients treated with intensity modulated radiotherapy (IMRT) is critical as small volume margins are used and the dose to the tumour may be escalated. Standard verification of treatment position for IMRT in head and neck cancer is performed using kV images acquired at simulation potentially introducing a systematic error. The use of digitally reconstructed radiographs (DRRs), produced directly from computerised tomography (CT) data, as the treatment verification reference image improves patient setup accuracy. DRRs have been introduced routinely for pelvic treatment verification, however the poor quality of images has restricted their use in head and neck clinical practice.

Method: A preliminary study group of five patients were scanned on a GE high speed QXI multi-slice scanner with a slice spacing and thickness of 2.5 mm and the resulting DRRs used for daily treatment position verification.

Result: As a result of moving from a GE single-slice helical CT scanner to a GE high speed QXI multi-slice CT scanner and by reducing image slice spacing and thickness DRR image quality has been significantly improved.

Conclusion: The resultant DRR images will be considered for use as reference images for daily patient treatment verification consequently streamlining the patient pathway by eliminating the simulator process and reducing the possibility of introducing a systematic error.

18. Percutaneous radiofrequency thermal ablation of bone metastases: preliminary results

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Purpose: To evaluate the efficacy of radiofrequency ablation (RFA) in patients with bone metastases for pain control.

Patients and methods: Thirteen painful metastases involving bone were treated in 11 patients (m 8, f 3; mean age 59.6, range 42–76) with RFA. Ten patients had osteolytic lesions, one had an osteoblastic lesion with pathological fracture. They were refractory to radiation therapy. Lesion dimensions ranged from 1.5 to 8 cm. Treatment was performed under CT guidance and focused on the interface between bone lesion and soft tissue, in order to obtain destruction of sensory afferent nerve fibres in the bone cortex and periosteum. Pain was measured using the Brief Pain Inventory—Short Form 1 day after the procedure, 2 weeks, 1 month and then every 2 weeks (total follow up 4–108 weeks). Patient use of analgesics was also recorded at these follow-up intervals. A CT control was performed 2 weeks after the procedure.

Results: The procedures were technically successful in all patients, with no major complications. Ten patients experienced a decrease in pain, with significant reduction of analgesic use. One patient had no benefit from RFA and underwent a cordotomy. Before treatment mean worst pain score was 7.0 (range 5–9); 4 weeks after RFA mean worst pain was 1.9.

Conclusions: Radiofrequency thermal ablation of bone metastases seems to be safe and to provide pain relief in patients refractory to radiation therapy.

19. Role of PET in detecting metastases and unknown primaries in head and neck squamous cell carcinoma (HNSCC)

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Background: Positron emission tomography (PET) has been previously shown to be useful in evaluating patients with HNSCC, but its role in locating unknown primaries is less well defined. Our aim was to review Stanford's experience with [^{18}F]fluorodeoxy-D-glucose PET to detect cervical and extracervical metastases and unknown primaries in HNSCC patients.

Materials and methods: Between October 1998 and January 2003, 51 patients at Stanford with newly diagnosed biopsy-proven HNSCC received whole body FDG-PET scans as part of initial staging workup. Forty-nine patients were men, and average age was 62.9 years. Primary tumours were located in the oral cavity (3), oropharynx (16), nasopharynx (2), hypopharynx (3), larynx (12), and unknown site (15).

Results: Of 18 patients with unknown primaries after imaging with CT and/or MR, PET located the primaries in four patients (22%). For the primary, PET revealed an oropharyngeal carcinoma not seen on other modalities in one patient. In five patients, FDG uptake was noted in the chest and judged to be tumours; three lesions were seen on chest CT performed before PET (6%) and two were seen on PET alone (4%). PET produced a false-negative result in one patient with lip carcinoma and one false positive. No false negatives were obtained for extracervical disease.

Conclusions: PET revealed the primary in 22% of patients with unknown primaries and changed staging in 6% of patients. PET is an effective staging study for unknown primaries in HNSCC and has a high sensitivity and specificity in locating extracervical metastases in HNSCC patients.

20. What is the prognostic value of [^{18}F]FDG-PET/CT in rectal cancer before treatment?

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Purpose: To evaluate the sensitivity of [^{18}F]FDG-PET/CT in detecting primary tumour and metastatic spread in patients with rectal cancer before any therapy.

Patients and methods: From January 2002 to October 2004, 64 (42 M, 12 F, mean age 64 years) consecutive patients with loco-regional non-operable rectal cancer were enrolled. Whole body FDG-PET/CT scan was obtained both before the start of RCT and after the end of RCT prior to surgery. PET/CT was obtained in fast conditions, acquisition 60 min after the injection of 10 mCi of FDG. SUVmax was calculated and compared to pathological findings.

Results: The present study is focused on 40 patients that completed the protocol. SUVmax at first FDG PET/CT examination ranged from 3.8 to 51 (mean 15.8); all patients had a positive PET. SUVmax reduced less than 50% in comparison with baseline pre-RCT value in 13 patients (group 1), between 50% and 80% in 12 patients (group 2), more than 80% in 15 patients (group 3). At post-RCT FDG-PET/CT five patients from group 1 developed distant metastases so were excluded from surgery and underwent second-line chemotherapy. No case of distant metastasis was observed among patients from groups 2 and 3. Despite the fact that the post-surgical follow-up is still not long enough (median 5 months) to calculate survival and disease free rates in this patient population, our data indicate that [^{18}F]FDG PET/CT is highly sensitive (100%) in visualising the primary tumour and unknown distant metastatic spread in patients with rectal cancer.

21. State of the art imaging: PET/CT in oncology

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Objective: To review the role of [^{18}F]FDG-PET/CT in the appropriate and optimal management of oncology patients.

Background: PET/CT, a relatively new imaging modality, is now recognised as a fundamental modality required for the appropriate and optimal management of oncological patients. There remains a widespread lack of availability of PET/CT in a number of European countries, however, together with a lack of knowledge or understanding regarding the role of this important modality relative to other more conventional imaging approaches in oncology such as CT, MRI or bone scintigraphy.

Results: Our now extensive experience is summarised in a general review detailing the role of PET/CT in oncology, with regard to staging, treatment response assessment, prognosis and defining recurrence. The role of PET/CT in a wide number of malignancies is addressed, and conditions in which PET/CT is not useful are also detailed. An indication is given of the relative place of PET/CT in the patient pathway compared to other modalities; the strengths of PET/CT compared to other imaging techniques are also defined. Some typical representative multi-modality radiological images from our large series are shown.

Conclusion: PET/CT is a critical modality required for the optimal management of patients with a number of different malignancies.

22. Weaknesses of [^{18}F]FDG-PET/CT in oncology

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Objective: To review the weaknesses of [^{18}F]FDG-PET/CT in oncological imaging.

Background: PET/CT is now widely recognised as a fundamental investigation required for the optimal management of patients with a number of different malignancies. Although PET/CT does clearly have a number of increasingly often quoted strengths compared to other imaging approaches, it is critical to appreciate that the test is not a universal panacea. There are strengths and weaknesses to all current oncological imaging modalities and [^{18}F]FDG-PET/CT is no exception; there are weaknesses of [^{18}F]FDG-PET/CT with regard to particular questions in different tumour settings. For patients to be appropriately managed it is clearly important to understand the limitations which currently apply.

Results: The key weaknesses of PET/CT in a range of different tumour types including lung cancer, upper and lower GI malignancy, head and neck malignancy, breast cancer, lymphoma, renal and testicular cancers and sarcomas are defined, with reference to staging, treatment response assessment and in defining recurrence in different tumour types. Representative multi-modality images from our large series are shown to illustrate a number of these points.

Conclusion: PET/CT is clearly a critical oncological imaging modality but it is important to understand the weaknesses of this technique in order to optimally manage oncology patients.

23. Role of [¹⁸F]FDG-PET/CT fusion imaging in disclosing the primary tumour in patients with malignant cervical lymphadenopathy from head and neck cancer

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Purpose: The head and neck (H&N) region is one of the most difficult anatomical areas of the body to investigate by FDG-PET. This may occur as a result of physiologic uptake in this area, mainly due to the presence of benign and hypertrophic lymphatic tissue. The aim of our study was to evaluate the role of hybrid PET/CT (Discovery LS, GE) in identifying the primary tumour in patients with cervical lymph node metastases.

Patients and methods: Twenty consecutive patients with metastatic cervical adenopathy from unknown primary tumour underwent FDG-PET/CT. Inclusion criteria were negative or inconclusive CT scan and MRI results, following physical examination.

Results: Focal areas of FDG uptake were observed in 16/20 (80%) patients. In three of them fusion PET/CT imaging allowed us to diagnose normal lymphatic tissue uptake or oral inflammation. In the other 13 [¹⁸F]FDG positive patients (65%) a focal asymmetrical radio-tracer uptake was shown and judged to be the site of the primary tumour. This finding was then confirmed by surgery in all 13 patients: three nasopharynx, four oropharynx, two palatine tonsil, three larynx, one parotid gland. The size of the primary tumour ranged from 8 to 22 mm, and SUVmax ranged from 3.3 to 7.0.

Conclusions: In our preliminary experience PET-CT fusion imaging appears to be able to significantly improve the localisation of the site of primary tumours.

24. Role of CT/PET in target volume definition for radiotherapy of patient with lung cancer

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Background: To validate the potential contribution of [¹⁸F]FDG-PET-spiral CT image fusion and to evaluate its usefulness in facilitating target volume definition.

Materials and methods: Nine patients with lung cancer (7 M, 2 F) with median age of 65.5 years (range 52–83) were enrolled from May 2004 to February 2005. Four patients had adenocarcinoma G1/G2, three had small cell carcinoma, one had squamous cell carcinoma and one had big cell carcinoma. CT and FDG-PET were obtained in treatment position in an integrated PET/CT scanner, and co-registered images were used for treatment planning. The system of immobilisation used included a β -cradle, a flat table top, three external fiducial markers and a laser position system. Both the CT and fused PET/CT were transferred to the radiation treatment planning workstation for contouring.

Results: The target volume is significantly changed by the co-delineation of CT/PET images and CT planning by either reduction of the radiation volume excluding atelectasis or mediastinal lymph node or increasing mediastinal lymph node involvement. Co-registered PET/CT showed good fusion accuracy. The resulting PET/CT GTV was medially reduced by 58.55% of the original CT GTV.

Conclusions: Fused PET/CT images for treatment planning for 3D-conformal radiation therapy reduced the interobserver variability in target volume definition compared with CT alone, minimised the dose of ionising radiation to no-target organs and finally reduced the risk for geographic misses.

25. Planning the boost volume for adjuvant breast irradiation: evaluation of target motion using 4D CT

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Aim: A study is being undertaken to evaluate respiration-associated tumour cavity (TC) motion in 20 patients referred for adjuvant breast irradiation using 4D-computed tomography (4DCT).

Materials: The standard planning (helical) is followed by a 4DCT scan from which the images corresponding to 10 time points within the tidal respiratory cycle are derived. The TC and a composite volume (CV), representing the composite of the TC at all 10-time points, are then delineated. Using a contour and centroid analysis, target motion and the single geometric margin required to address it are estimated.

Results: Results from the first five patients indicate that the average TC is 11 cm³ (range 7–21 cm³) and represents only 0.8% (range 0.6%–2%) of the treated breast volume. The average CV is 16.6 cm³ (range 10.2–29 cm³) and can exceed the standard TC by 48% (range 35%–87%).

On 4DCT, the volume of the TC does not differ significantly between inspiratory and expiratory phases: mean difference 1.1 cm³ (10% of average TC), $p = 0.08$ (paired t -test). The magnitude of the centroid of the TC motion varies between patients and in different directions within a patient, ranging from 1 to 3 mm. In the Planning CT, a margin of 5 mm, when applied to the TC, would encompass the corresponding CV.

Conclusions: 4DCT demonstrates the limited TC motion during tidal breathing. Application of 5 mm to the tumour cavity in the standard planning CT may suffice as internal geometric margin, when delineating the planning target volume for boost or for partial breast volume irradiation techniques.

26. Low dose Sestamibi radio-guided surgery of non-functioning metastatic thyroid cancer

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Background: When metastases of differentiated thyroid cancer (DTC) lose their capability to trap ¹³¹I, re-operation alone or combined with external radiotherapy is usually applied. In the present study, we evaluated the potential role of radio-guided Sestamibi surgery in ¹³¹I-negative loco-regional metastatic DTC. Inclusion criteria in our protocol were: (a) absence of ¹³¹I uptake after a therapeutic ¹³¹I dose; (b) demonstration of loco-regional metastatic spread by Sestamibi scan and high resolution neck ultrasound (SU); (c) a clear uptake of Sestamibi in neoplastic lesion(s).

Patients and methods: Thirty-eight consecutive patients were enrolled in the study (20 F, 18 M, mean age 41.8 ± 16.8 years, 30 papillary, 3 follicular, 2 Hurtle, 1 tall cells, 2 poorly differentiated histotype). All patients had been previously operated by total thyroidectomy and had received 1–6 therapeutic doses of ¹³¹I. Preoperative serum thyroglobulin levels (Tg) were 101 ± 192 ng/ml. The preoperative imaging protocol included same-session Sestamibi 740 MBq dual-phase scan of neck, US and FNAC. All patients were re-operated by standard bilateral neck dissection. An 11 mm collimated probe was used for radio-guided surgery; the operation started 10 min after the injection in the operating theatre of a low 37 MBq (1 mCi) Sestamibi dose.

Results: A total of 79 metastatic lesions were removed (mean size 18.7 ± 8.3 mm); 68 of them were Sestamibi-positive.

Conclusions: The probe was judged by the surgeon to be useful in helping the intraoperative detection of Sestamibi-avid neoplastic foci and in performing an accurate extirpation of the lesion by checking the operative basin after metastasis removal.

27. Sonographic evaluation and FNAC of neck nodes in lung cancer: when should it be done?

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Aim: Ultrasound (US) examination of the neck is an important imaging modality in the staging and assessment of patients with lung cancer. Fine needle aspiration cytology performed at the same time, under US guidance, of abnormal nodes is a fast, accurate and safe method of obtaining a cytological diagnosis and may spare the patient more invasive diagnostic procedures.

Indications and technique: This can be performed on patients with poor respiratory reserve or in whom biopsy of the primary lung tumour poses a high risk of complications; e.g. emphysema and fibrosis. US is useful in guiding the FNAC in palpable neck nodes and for the detection of impalpable nodes. It is a simple technique and requires no anaesthesia or preparation and can be performed in an outpatient clinic. The neck is scanned using a 7.5 MHz probe in the longitudinal and transverse planes from the level of the mandible to the clavicles bilaterally and the abnormal nodes are aspirated using a 22G needle and smears sent for cytology.

Conclusion: The technique and indications of US guided FNAC have been found to be safe and simple in the staging and pre-treatment assessment of lung cancer.

28. CT-guided thoracic core biopsies: value of a negative result

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Aim: Previous studies have reported low negative predictive values (NPV) for CT-guided fine needle aspiration of lung nodules in excluding malignancy. The aim of this study was to determine the NPV of transthoracic core needle biopsy in a tertiary care hospital with a large cancer patient population.

Methods: The results of 231 consecutive CT-guided transthoracic core needle biopsies performed between 26 March 2002 and 26 April 2005 were reviewed. Results were classified into one of the following four groups: positive or suspicious for malignancy, benign specific, benign non-specific, and non-diagnostic. The benign specific group included entities such as fungus, hamartoma and schwannoma. In the benign non-specific group, histologic findings such as scar and inflammation were reported. The non-diagnostic group included cases with only normal pulmonary tissue in the specimen and/or insufficient tissue to render any diagnosis. The results were correlated with subsequent proof obtained via surgery or clinical and imaging follow-up.

Results: One hundred and sixty-two biopsies were positive or suspicious for malignancy, eight were benign specific, 32 were benign non-specific and 29 were non-diagnostic. Forty-four benign non-specific or non-diagnostic cases had subsequent proof, and malignancy was subsequently confirmed in 16/44 cases (5/21 benign non-specific and 11/23 non-diagnostic cases). The negative predictive values were 76% and 52% for benign non-specific and non-diagnostic biopsies, respectively.

Conclusion: A core biopsy revealing non-specific benign tissue or insufficient tissue for diagnosis is unreliable in excluding malignancy, and patients with these types of biopsy results should have resampling of tissue or close clinical and imaging follow-up.

29. Atypical localisations of metastases from pulmonary carcinoma: CT findings

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Aim: The modern therapeutic protocols employed in the treatment of pulmonary cancer have determined a prolonged time of survival with changes of metastatic spread and involvement of unusual organs regarding the classic centres. Our objective is to describe several CT findings of secondary localisations in atypical sites found from the retrospective appraisal of 300 patients with pulmonary carcinoma.

Materials and methods: Three hundred patients (185 males, 115 females) with pulmonary carcinoma have been evaluated with total body helical contrast-enhanced CT. Typical areas of metastasis are the brain, liver, remaining lungs, hilar and mediastinic lymphatics, adrenal glands and bone; metastasis in unusual areas were confirmed by histologic examination for CT patterns and for changes in follow-up controls.

Results: Forty patients with metastasis in atypical areas were identified: 15 soft tissues (9 skeletal muscle and 12 subcutaneous tissue), ten renal and peri-renal metastasis, five pancreatic, three intestinal, four splenic, three cardiac, one mammary, two medullary dura, one thyroid gland and one in the optical nerve. Of these patients, 30 had multiple metastases with multiple organ involvement. Histology of primary neoplasms were small cell carcinoma in 22 patients, adenocarcinoma in 10 and epidermoid carcinoma in eight.

Conclusions: Usually metastasis in unusual areas is a sign of advanced neoplastic disease. However, they can also happen as the first sign of metastasis; knowledge of their existence and identification is important for accurate staging of neoplasms.